

Willow Creek Subbasin Water Quality Monitoring Report Phase II

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Technical Report Summary
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Introduction

The Idaho Association of Soil Conservation Districts (IASCD) recently conducted Phase II of a monitoring project in the Willow Creek subbasin in eastern Idaho. Willow Creek is a tributary to the Snake River and enters the river about 1 mile north of Idaho Falls. The subbasin is approximately 647 square miles in size and is located in the Eastside and North Bingham Soil Conservation Districts (SCD). Willow Creek originates from streams that drain the east side of the Blackfoot Mountains and the subbasin is bordered on the south and east by the Grays and Caribou mountain ranges. Phase II of this monitoring project concentrated on Willow Creek and five of its tributaries; Birch, Squaw, Sellars, Seventy, and Mill creeks. Squaw Creek was added to determine if it contributed to the high pollutant loads observed in Birch Creek during Phase I. The remainder of the sites were monitored to investigate elevated nutrient levels that were measured during Phase I of the project.

The Willow Creek TMDL was written by the Idaho Department of Environmental Quality (IDEQ) and approved by the Environmental Protection Agency (EPA) in June 2004. All of the streams included in this report, with the exception of Squaw Creek, were on the state of Idaho §303(d) list for having water quality limited segments. Every 303(d) stream was listed for

sediment and Sellars, Mill, and Seventy creeks were additionally listed for temperature. Sediment TMDLs were developed for Willow, Sellars, Mill, and Seventy creeks and temperature TMDLs were developed for Sellars, Mill, and Seventy creeks. A nutrient TMDL was written for Willow Creek because DEQ observed nuisance aquatic vegetation and low dissolved oxygen levels in parts of the watershed. TMDLs were not developed for Birch Creek because it was determined to be primarily flow altered. However, during Phase I of this project Birch Creek exhibited the poorest water quality in the subbasin. Therefore, we continued monitoring efforts on Birch Creek and the tributary Squaw Creek was added. The beneficial uses designated for these streams are cold water aquatic life (CWAL), salmonid spawning (SS), primary contact recreation, secondary contact recreation, domestic water supply, and special resource water.

Table 1. Pollutant targets for stream segments in the Willow Creek subbasin (DEQ 2004).

Pollutant of Concern	Pollutant Targets for the Willow Creek TMDL
Total Suspended Solids (not specified in TMDL)	Best condition (<25 mg/L) Some effects (25-80 mg/L) Definite effects (>80 mg/L)
Nitrate + Nitrite	Not to exceed 0.30 mg/L
Total Phosphorus	Not to exceed 0.10 mg/L or 0.05 mg/L (Willow Creek)

This monitoring project was initiated at the request of the Eastside Soil and Water Conservation District (SWCD). The project goal was to provide water quality data to districts to allow for identification of potential pollutant sources and to quantify pollutant concentrations in the tributaries. During Phase I we monitored throughout the watershed and observed elevated nitrogen levels in upper Willow and Sellars creeks. Therefore, Phase II of this project was developed to better pinpoint sources of nitrogen in the subbasin and efforts were focused on streams in the upper reaches of the Willow Creek subbasin. The data will be used to plan implementation of voluntary agricultural best management practices (BMPs) throughout the Willow Creek subbasin. IASCD has worked cooperatively with Idaho State Department of Agriculture (ISDA), the Eastside SWCD and the North Bingham SCD to implement this project.

Monitoring Schedule and Site Descriptions

Phase II monitoring was conducted at nine sites in the upper Willow Creek watershed from March – September 2005. This monitoring complements data that were collected during Phase I from 2003 to 2004. Four sites from Phase I were continued: Willow 1, Willow 2, Birch, and Sellars 1. Five new sites were added during Phase II: Squaw, Sellars 2, Mill, Seventy, and Willow 3 (Figure 1).

Willow Creek is the primary stream in the subbasin and was monitored at three locations. The downstream monitoring site on Willow Creek was located above the Kepp's Crossing bridge, Willow 2 was below Pole Bridge, and the upper site, Willow 3, was monitored approximately 2.75 miles above the confluence with Crane Creek.

Birch Creek (BC) was monitored below the confluence with Squaw Creek, approximately one mile before it flows into Willow Creek. Squaw Creek was monitored upstream of Birch Creek. Sellars 1 was monitored upstream of Long Valley Road. Further upstream, Sellars 2 was monitored above Bone Road. Mill Creek was monitored below the confluence with Buck Creek, approximately 0.3 miles upstream of its confluence with Willow Creek. The monitoring site on Seventy Creek was located 0.7 miles above Willow Creek.

IASCD monitored twice a month from March to September. However, Mill, Seventy, and Willow 3

were not accessible until the end of May due to road closures. During each visit, samples were collected for total suspended solids (TSS), total volatile solids, total phosphorous (TP), orthophosphorus, nitrate + nitrite, and ammonia. Field measurements were taken for stream discharge, temperature, dissolved oxygen, pH and conductivity. We measured dissolved oxygen over a 24 hour period at select sites in August.

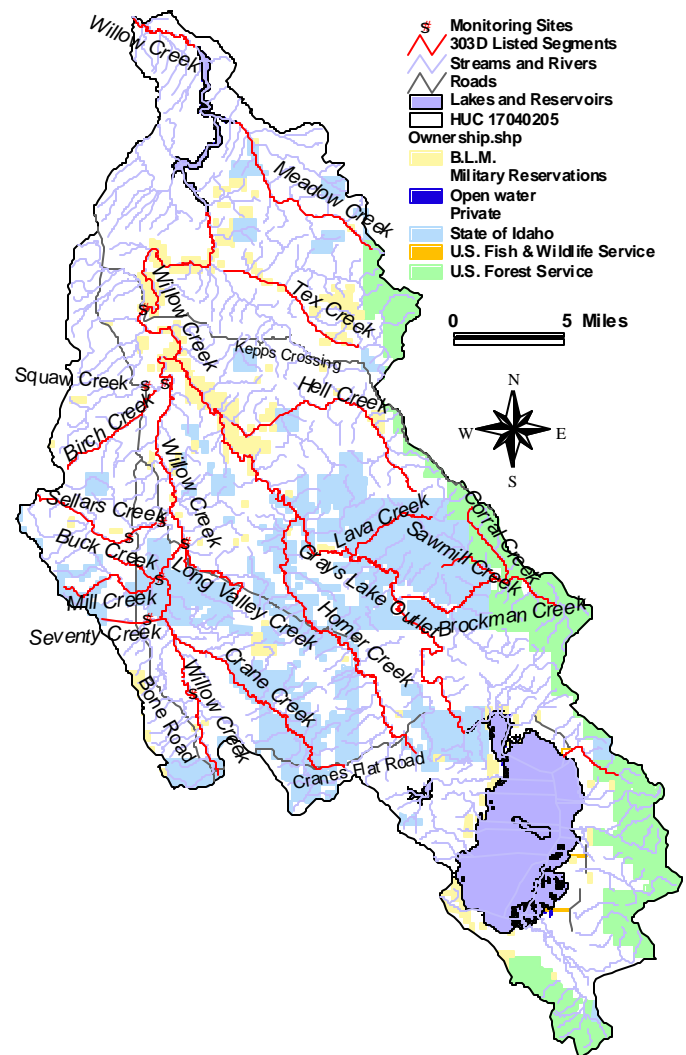


Figure 1. IASCD monitoring locations in the Willow Creek subbasin (Phase II).

Results

Discharge

Discharge rates of the streams fluctuated seasonally as is common in systems that are largely influenced by snow melt (Figure 2). Stream flows peaked during spring months and declined to base flows for the remainder of the year.

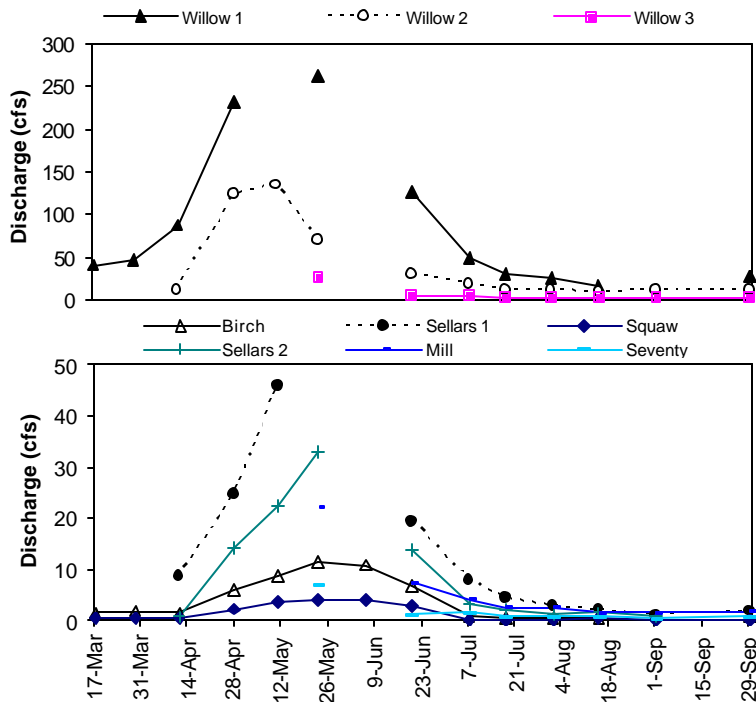


Figure 2. Stream discharge from March to September 2005.

Discharge rates were highest at Willow Creek at Kepp's Crossing (Willow 1) and lowest in Squaw Creek (Figure 3). Discharge at the Willow 1 site was significantly higher than any other site ($p < 0.046$), with the exception of the Willow 2 site. Squaw Creek is a tributary to Birch Creek and accounted for 13-46% of flows in Birch Creek during most of the year. In August, Squaw Creek was responsible for 60-72% of the flow at the Birch Creek site.

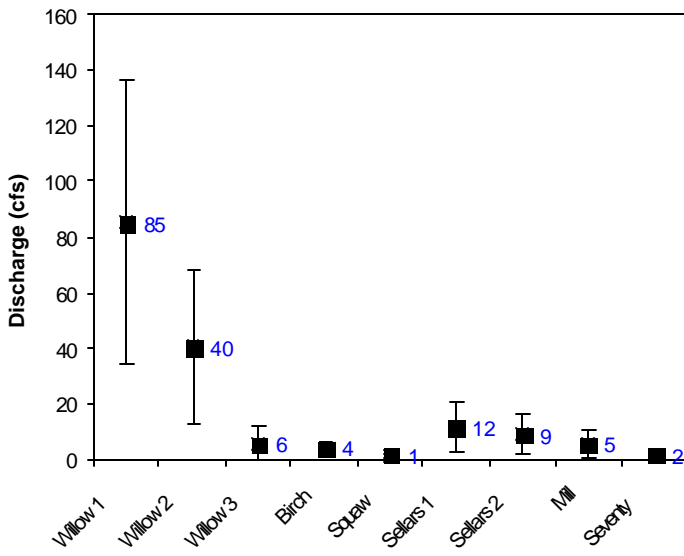


Figure 3. Mean stream discharge (cfs, \pm 95% confidence interval) at the nine monitoring sites.

Total suspended solids

Total suspended solids (TSS) concentrations at many of the sites fluctuated on a seasonal basis (Figure 4). As is typical of snowmelt dependent systems, TSS levels increased during spring runoff events and declined to low levels throughout the rest of the year. Exceptions to this were Squaw, Mill, Seventy, and Willow 3. Squaw Creek experienced elevated TSS concentrations throughout the year, with the highest measurement in September. TSS in Mill, Seventy, and Willow 3 were low throughout the year, with minor fluctuations. Mill, Seventy, and Willow 3 may have experienced elevated TSS levels earlier in the year (typical of snowmelt dominated systems), but this was not documented because streams were inaccessible until May.

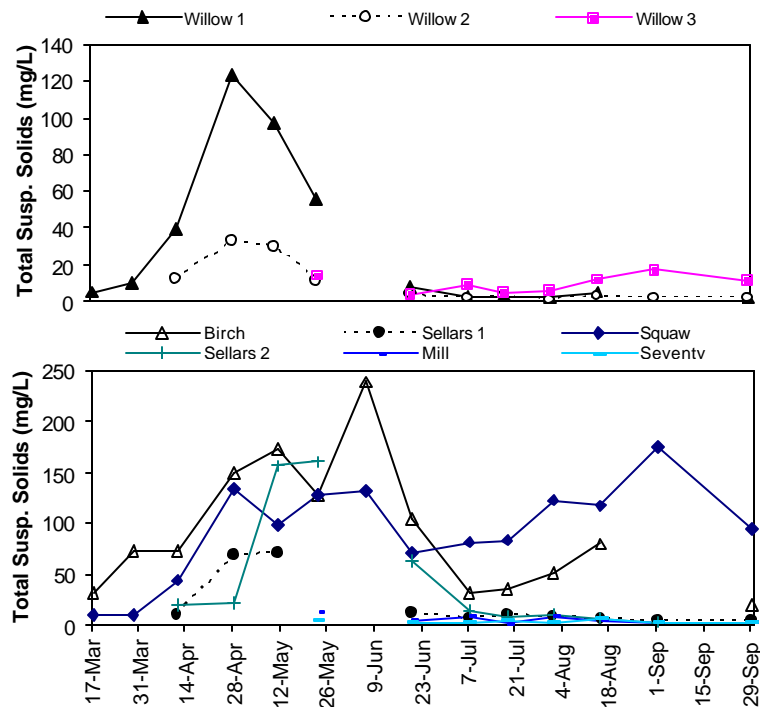


Figure 4. Total suspended solids (mg/L) measured from March to September 2005 in the Willow Creek subbasin.

Mean TSS concentrations at most sites were low and did not exceed the 80 mg/L target (Figure 5). This was not the case for Birch and Squaw creeks where mean TSS levels exceeded 80 mg/L and indicated that there may be a significant negative impact on cold water aquatic life. TSS levels in Birch and Squaw creeks were significantly higher than any other stream ($p = 0.010$) except Sellars 2. Squaw Creek had a small to moderate impact on TSS in Birch Creek from March through June, accounting for 3 to 36% of the TSS load

(lbs/day). However, from July to October Squaw Creek accounted for 49 to 100% of the TSS load in Birch Creek. Sources of sediment in Birch and Squaw creeks may be livestock grazing, animal feeding operations, and water withdrawals and storage ponds that result in streambank instability (Pappani 2006). Mean TSS at Willow 2, Willow 3, Mill, and Seventy creeks were well below 25 mg/L and were not significantly different from each other.

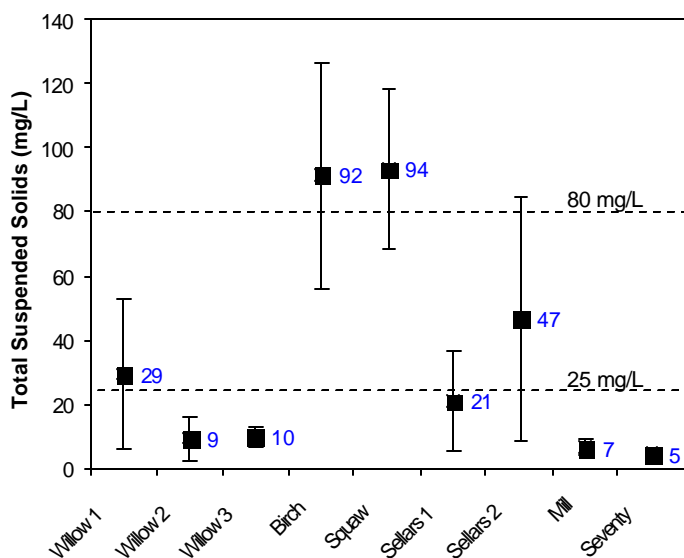


Figure 5. Mean total suspended solids (\pm 95% confidence intervals) measured at the nine monitoring sites. The horizontal dashed lines represent the water quality targets of 25 and 80 mg/L.

Total phosphorus

Total phosphorus (TP) concentrations at the nine sites fluctuated throughout the year (Figure 5). With the exception of Squaw creek, TP levels were highest during the spring and early summer months. In Squaw Creek TP paralleled TSS; concentrations increased throughout the year and peaked in September. Birch and Squaw creeks exceeded the 0.1 mg/L target 100% of the time. Pappani (2006) noted that channel alteration, livestock grazing, and animal feeding operations appeared to negatively impact water quality and stream functioning on Birch Creek. Willow Creek drains directly to Ririe Reservoir and therefore has a lower TP target (0.05 mg/l). The Willow Creek sites often exceeded the target, but values were not typically high.

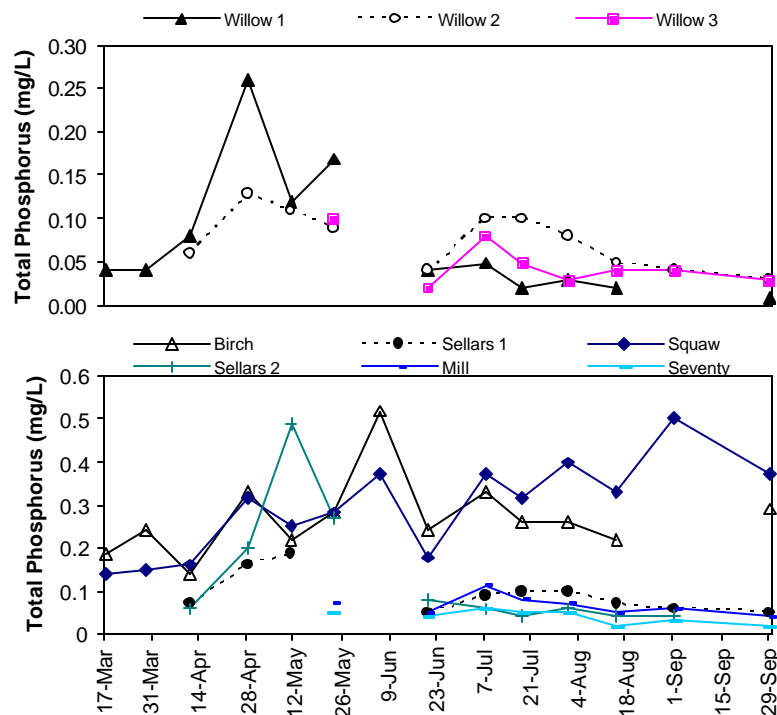


Figure 6. Total Phosphorus (mg/L) measured from March to September 2005.

Average TP concentrations at Birch, Squaw, and Sellars 2 exceeded the 0.1 mg/L target. Willow 1 and 2 exceeded the lower 0.05 mg/L target for streams draining to reservoirs (Figure 7). On average, TP levels in Birch and Squaw creeks were similar and were significantly

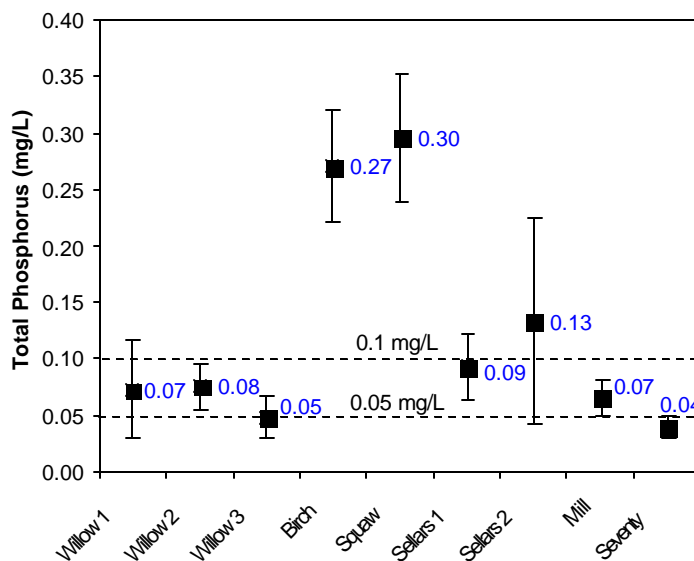


Figure 7. Mean total phosphorus (TP, mg/L) measured at the nine sites from March to September 2005. The horizontal dashed lines represent the DEQ targets of 0.1 and 0.05 mg/L (Willow Creek).

higher than the other sites ($p = 0.012$). Squaw Creek accounted for 93-100% of the TP load (lbs/day) in Birch Creek in August, but was only 11-50% of the load during the rest of the year. TP did not differ significantly among the three Willow Creek sites. On average Willow 3, Sellars 1, Mill, and Seventy creeks met the DEQ targets for TP.

Nitrogen

During Phase I, nitrogen was identified as a pollutant of concern in the watershed. Phase II monitoring was conducted in an attempt to locate source areas of nitrogen in the upper watershed. Nitrogen (nitrate + nitrite, mg/L) concentrations across the nine sites exceeded the 0.3 mg/L target 75-100% of the time.

Nitrogen levels fluctuated throughout the year at the nine sites, but typically did not follow a seasonal pattern (Figure 8). The one exception was Sellars 2 where nitrogen peaked slightly during spring runoff and decreased through the rest of the year. This seasonal pattern may be due to runoff from rangeland or may indicate inputs from septic systems in the Sellars Creek watershed. Elevated groundwater levels associated with spring runoff may result in transfer of nitrogen from septic drain fields to Sellars Creek.

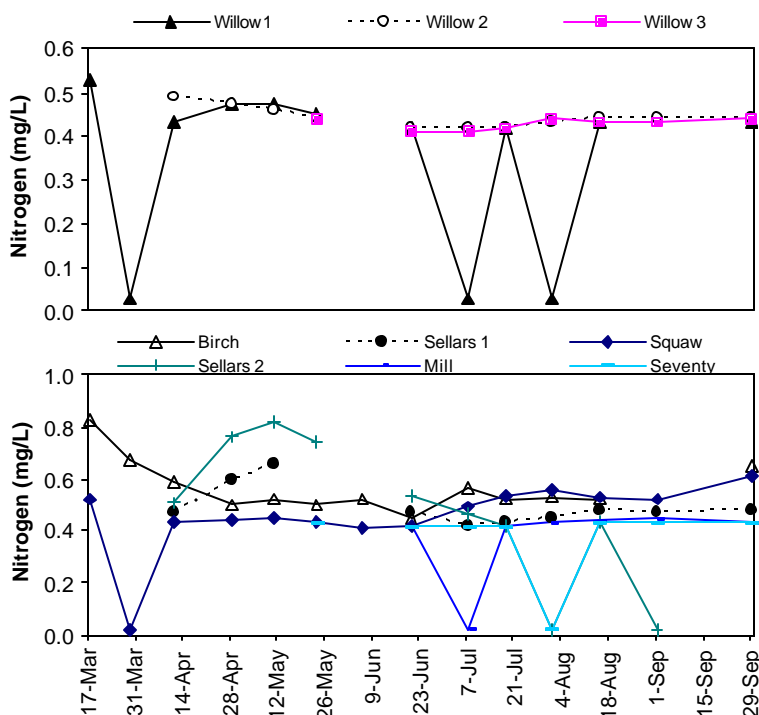


Figure 8. Nitrogen concentrations (nitrate + nitrite, mg/L) measured at the nine sites in the Willow Creek subbasin from March to September 2005.

Average nitrogen concentrations at all sites during the Phase II monitoring exceeded the 0.3 mg/L target (Figure 9). Despite this, average levels at most sites were not exceptionally high. Nitrogen concentrations were significantly higher in Birch Creek than in every other stream ($p = 0.025$) except Sellars Creek. Average nitrogen levels were lowest at the Willow 1 site. However, due to the large amount of variation, the Willow 1 site did not differ significantly from the upstream Willow 2 and 3 sites or any streams except Birch and Sellars 1. The nitrogen load (lbs/day) in Birch Creek was significantly impacted by Squaw Creek during August (64-73%), but only slightly to moderately impacted the rest of the year (1-43%).

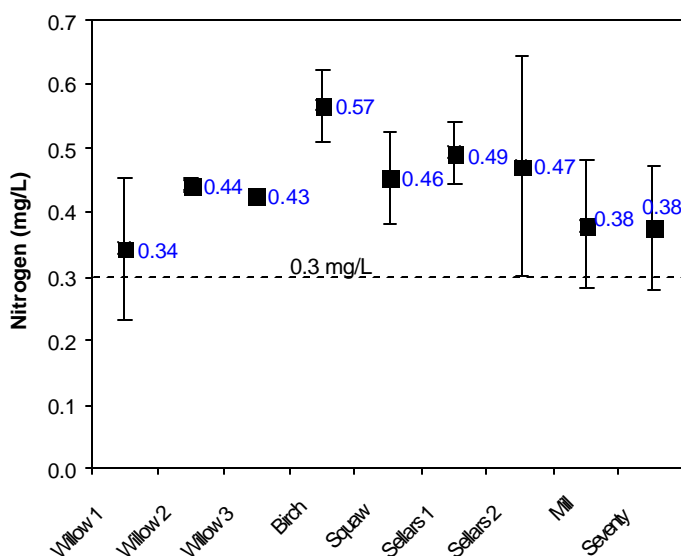


Figure 9. Nitrogen levels (nitrate + nitrite, mg/L) measured at the nine sites in the Willow Creek subbasin from March to September 2005. The horizontal dashed line represents the IDEQ target of 0.3 mg/L.

We were not able to detect a source area for nitrogen in the Willow Creek subbasin. Instead, all streams exhibited nitrogen levels that exceeded the water quality target. Currently, the only widespread landuse in the upper subbasin is livestock grazing. However, the consistently elevated nitrogen levels observed in these streams cannot be fully explained by seasonal livestock grazing. The nitrogen concentrations in the Willow Creek subbasin may be similar to natural background levels or may be elevated due to human activities. Anthropogenic increases in atmospheric nitrogen have resulted in an increased rate of deposition on land surfaces during precipitation events and could account for some of the nitrogen in the watershed. Additionally, the upper Willow Creek

subbasin may still be impacted by historic landuse practices such as non-irrigated cropland. Until the 1990s, wheat, barley, and alfalfa were grown in parts of the watershed. Current nitrate levels may be the result of leaching from these retired crop fields.

Dissolved Oxygen Monitoring

As mentioned above, nitrogen was elevated throughout the upper Willow Creek watershed. However, nitrogen levels were not extremely high and it was unclear whether these levels impair beneficial uses. Excess nutrients are a concern in streams because they can be responsible for nuisance aquatic vegetation and diel dissolved oxygen (DO) depletions that negatively impact fish and aquatic invertebrates. DO concentrations below 6 mg/L are considered harmful for cold water aquatic life. In August 2006, we monitored DO levels over a 24 hour period in Birch, Sellars 1, and at the Willow 3 site (Figure 10) to determine if beneficial uses were being impacted.

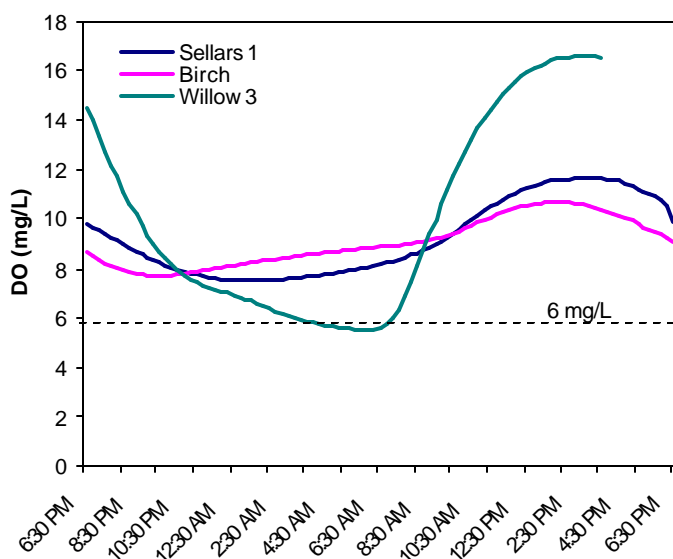


Figure 10. Dissolved oxygen levels (mg/L) at three sites in the upper Willow Creek subbasin. The dotted line represents the water quality standard of 6 mg/L.

As is common, DO concentrations at the three sites fluctuated daily. DO levels were highest during the afternoon due to photosynthesis by aquatic plants and decreased during the evening/early morning periods when plants consumed the available oxygen. DO fluctuated in Sellars 1 and Birch creeks but did not fall below the water quality standard during the 24 hour period. The Willow 3 site exhibited the most significant variation in DO levels and fell below the 6

mg/L standard for four hours. We may have missed the greatest window for detection of DO depletions because by August nighttime air temperatures had started to decline. Therefore it is reasonable to assume that the Willow 3 site experiences DO depletions below the water quality standard for at least the months of July and August.

Conclusions

The seasonal elevation of TSS and TP is common in snowmelt dependent systems. Despite the seasonal fluctuations, TSS levels were often low at seven of the nine sites. However, the majority of measurements from Birch and Squaw creeks did exceed the 25 mg/L target, and 86-92% of measurements exceeded the 80 mg/L target. Squaw Creek did not exhibit the seasonal pattern observed in other streams in the subbasin. Instead, Squaw Creek experienced elevated TSS levels throughout the year with the highest concentrations occurring in September.

TP concentrations were not extremely high at many of the sites in the subbasin. Again, exceptions to this were Birch and Squaw creeks, where TP mimicked TSS concentrations throughout the year. While the sites on Willow Creek experienced relatively low TP levels, on average, Willow 1 and Willow 2 exceeded the lower 0.05 mg/L target for streams draining to a reservoir. Efforts to limit the input of sediment (and consequently phosphorus) to Birch and Squaw creeks should be made by improving man-made structures, conducting grazing management plans, and improving livestock feeding areas. Reductions in Willow Creek during high flow events may be accomplished by implementing sediment reduction BMPs such as riparian buffers and grazing management.

Nitrogen levels were elevated at all nine sites monitored during Phase II. All nine sites exceeded the target more than 75% of the time and Birch, Squaw, Sellars 1, Willow 2, and Willow 3 exceeded the 0.3 mg/L target 100% of the time. In Birch and Squaw creeks animal feeding operations and livestock grazing may contribute to elevated nitrogen concentrations. In the upper reaches of the subbasin nitrogen may be related to natural background levels or land use practices. Current impacts in upper Willow Creek are limited to livestock grazing. Historically, the area was cultivated for barley, wheat, and alfalfa. These current and historic impacts may have resulted in elevated nitrate levels over time.

Additionally, the Willow Creek subbasin receives a large amount of snowfall and deposition of atmospheric nitrogen via precipitation may explain some of the nitrogen in the watershed.

While exceedances were numerous, nitrogen levels were low relative to other watersheds in southeastern Idaho. To determine if nitrogen concentrations were elevated to the extent that they negatively impacted beneficial uses, we measured dissolved oxygen over a 24 hour period in three streams. The uppermost Willow Creek site (Willow 3) experienced depletions of DO below the state standard for cold water aquatic life. This indicates that nitrogen levels may be responsible for nuisance levels of aquatic vegetation and a resulting negative impact on fish and other aquatic species in the upper reaches of Willow Creek. Sellars and Birch Creek did not experience significant depletions of DO during nighttime periods and nitrogen levels in these streams may not negatively impact beneficial uses.

Attempts to decrease nitrogen inputs in the upper Willow Creek subbasin may be difficult to accomplish. Historic practices such as dry farming may still be influencing water quality and would be impractical to treat. Nitrogen deposition via precipitation is a global problem and not feasible to address on a watershed scale. Livestock grazing is the only existing widespread practice in the watershed. Efforts to decrease nitrogen levels in the stream could be made by conducting grazing management plans and constructing exclusion fence. However, due to the size of the watershed and the widespread elevated nitrogen levels, the benefits of these practices may not offset the costs of implementing them.

Recommendations

The results of this monitoring project helped to identify water quality limited streams in the subbasin. Birch and Squaw creeks exhibited the poorest water quality of the streams monitored and should be prioritized for BMP implementation. The data included in this report indicate that Birch and Squaw creeks should be included on the state of Idaho §303(d) list for suspended sediment and nutrients. Squaw Creek appears to have a negative effect on water quality in Birch Creek, especially during late summer when it accounts for most of the water in Birch Creek. Squaw Creek exhibited the poorest water quality during August and September and this seasonal

degradation of water quality should be investigated. We feel that significant improvement in water quality on these streams may be achieved by implementation of BMPs such as exclusion fencing, offsite watering, berms to contain animal wastes and sediment from feeding areas, filter strips to capture sediment and nutrients, and examination of water storage systems.

Concentrations of TSS and TP were higher at the upper Sellars Creek site (Sellars 2) compared to the lower site. Therefore, BMPS to reduce sediment and nutrients should be focused on the upper reaches of Sellars Creek. Implementation of exclusion fences, grazing management, as well as investigation of septic system performance may improve water quality in Sellars Creek.

Seventy and Mill creeks experienced relatively good water quality throughout 2005 and should be low priorities for implementation.

Willow 1 and Willow 2 experienced increases in TSS and TP associated with spring runoff. Willow Creek should be visually assessed to determine stream reaches that could benefit from BMPs such as filter strips, riparian vegetation improvement, and exclusion fencing projects.

Acknowledgements

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